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A COMPARATIVE STUDY OF THE HERD STRUCTURE BETWEEN THE FERAL OGASAWARA GOATS AND THE DOMESTIC SAMBURU GOATS

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ABSTRACT Socio-ecological and behavioral data of the domestic goats reared by the pastoral Samburu of northern-central Kenya are analyzed in comparison with those of the feral goats of Chichijima Island, Japan, for inference on the process of domestication of bovine livestock. The pastoral and feral goats' behaviors are compared with those of wild bovine species. With regard to the origin of pastoral herds, the results suggest that the hypothesis assuming that man first caught infants and formed the livestock herds is more plausible than assuming that man habituated a natural group of animals as a whole.

Key Words: Samburu; Domestication; Goat; Pastoralism; Herding; Bovine behavior and ecology.

INTRODUCTION

The life of pastoral people is supported by their herds of livestock. Their major foods are livestock products such as milk, blood, and meat. The money for purchasing commodities from the outside societies, such as sugar, tea, maize meal, and beads, is earned by selling their livestock. Skins and wastes of livestock are used for many purposes. Moreover, the important social ritual ceremonies, such as birth, circumcision, and marriage, are not held without sacrificing any livestock. Thus it is not until the pastoral people gain the livestock herd that they can continue their everyday life smoothly.

Dahl & Hjort (1976) estimated the required minimum livestock herd size for one family of 4.9 adult equivalents as follows: Assuming that all meat and blood from animals that die from natural causes and from emergency slaughters can be used, a cattle herd of 50 or more animals is sufficient to provide this family with their calory and protein demands. If this family subsist exclusively on products from their small stock, considerably more than 100 head are needed to meet the family's caloric need, while well over 50 animals are needed for protein.

The pastoral people must maintain and even increase such large livestock herds. For this purpose the pastoral people generally adopt the way of livestock keeping called the day-trip herding. After departing from the settlement in the morning, a few herders control a large herd in the wilderness without any fences, and return again to the settlement in the evening.

As stated by several authors, such a way of herding is obviously accomplished on the basis that the livestock has a behavioral tendency to aggregate (e.g., Umesao,

1976; Tani, 1976). It is known, however, that there are many kinds of aggregations and ways of gregariousness. How do goat and sheep aggregate? Can the social structure and the manner of ranging of such ungulates be concluded just the same as those of primates such as the Japanese macaque or the gorilla? Is the aggregation of the domestic stock just the same as that of the wild ungulates?

Ohta (1982) stated that both the behavior of domestic animals and the maintenance of the pastoral herd reflect the outcome of the interactions between man and the domestic animals. To understand all the interactions between man and the domestic animals is nothing but to understand the pastoral mode of life. Both how the pastoral herd, which support the life of the pastoral people, is formed as a result of the interactions between man and animals, and how the pastoral people do the day-trip herding of this pastoral herd are the basic questions to the research on pastoralism.

For elucidating these questions it is necessary first of all to understand the differences between the natural herd of closely related wild animals and the pastoral herd. Also, it is necessary to relate these results with man's mode of managing the domestic animals. These works are prerequisite for dealing with the interactions between man and animals on the forming of the pastoral herd, and thus the relationship between the pastoral people and the domestic animals.

This paper deals mainly with goat, which is known to have been domesticated from the oldest time as well as the sheep. I tackle these problems on the basis of my research on the domestic goats reared by the pastoral Samburu of northern-central Kenya and those on the feral goats of Chichijima Island in the Ogasawara Archipelago, Japan. Although I also collected data on the socio-ecology of the pastoral Samburu, on their cognitive and naming systems with regard to the domestic animals, and on the cases of exchanging the livestock and so on, but the analyses and discussions of these topics will be published elsewhere.

In this paper, I use the phrase "pastoral herd" for the aggregation of domestic animals, and "natural herd" for the aggregation of wild or feral animals.

THE PASTORAL SAMBURU

I. Ecological Background of the Pastoral Samburu

The Samburuland is roughly divided into three parts (Fig. 1): the south-western Leroghi Plateau, over 1,500 m a.s.l.; the central lowland (*lpurkel*, pl. *lpurkeli*), under 1,500 m; and the mountain ranges from north to southeast. Leroghi Plateau is the northernmost part of the Kenya Highland which includes the Nairobi area. There is a montane forest (*supuko*, pl. *supuk/supok*) around Maralal on Leroghi, the center of the Samburu District. The mountain ranges lie on the borders between the northern Rendilleland and the Samburuland. The Mount Kulal, Nyiru Range, Ndoto Mountains, and Mathews Range stretch from north to southeast. There are also found montane forests. The study area is around Barsaloi in the central lowland (Fig. 2).

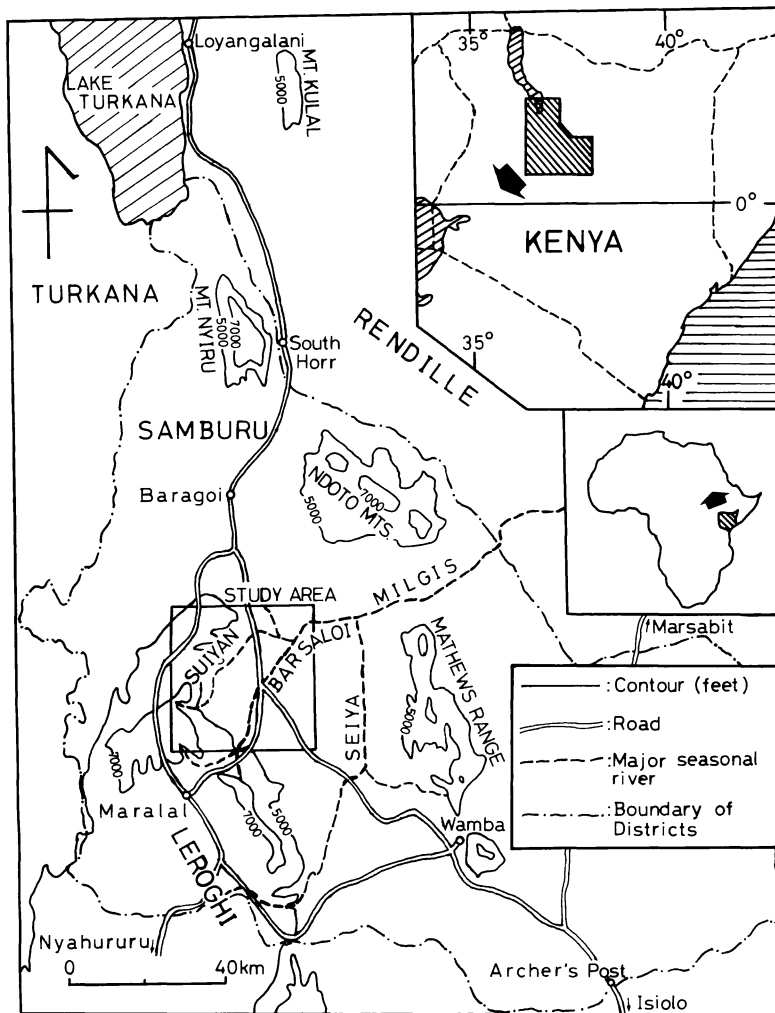


Fig. 1. Samburuland.

The average annual rainfall is less than 450 mm. The Samburu distinguish the rainy season (*lari*, pl. *larin*) and the dry season (*lamei*, pl. *lameitin*; *nkolong'*, pl. *nkolong'*; both terms mean hunger). They divide one year into four seasons: *lgergerwa*, the rainy season around April; *lamei dorop* ("short hunger"), the minor dry season around August and September; *ltumuren*, the rainy season in November; and *lamei yodo* ("long hunger"), the major dry season from January to March. In such highland areas as Maralal and Marti, there is the minor rainy season called *lorikine* after *lgergerwa*. The dry and the rainy seasons alternate in the lowland. It rains only during the two periods from March through May and from October through Decem-

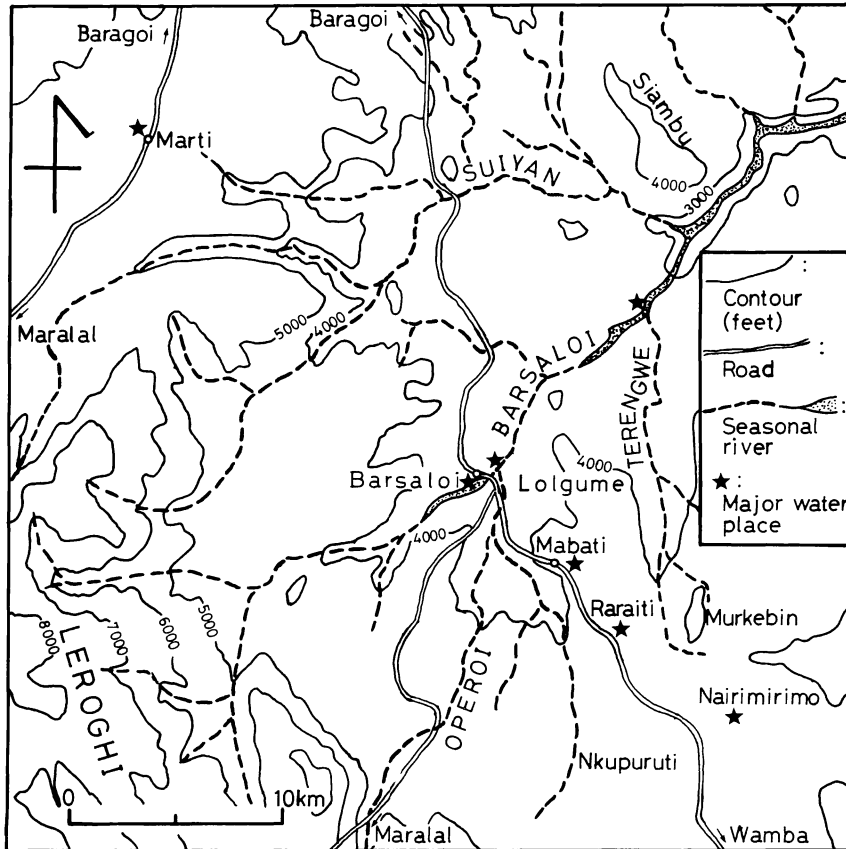


Fig. 2. Study area.

ber.

There are many seasonal rivers running in the lowland. The main ones are the Suiyan, the Barsaloi, and the Seiya. They join one by one, and become the Milgis, which reaches the Rendilleland. There are three major vegetation types in the lowland: the riverine forest, the *Acacia* woodland, and the semi-desert. The riverine forest (*ranpaso*, pl. *ranpason*), where *Acacia tortilis* (*Itepes*) dominates, develops along the big seasonal rivers. The *Acacia* woodland (*saar*, pl. *saari*), where other kind of *Acacia*, such as *A. mellifera* (*iti*) and *A. senegal* (*Iderikesi*), and several species of *Commiphora* such as *C. africana* (*laichemi*) dominate, mainly develops on the foothills of Leroghi Plateau. The vegetation type of the remaining vast area consists of the semi-desert (*lekarjaji*, pl. *lekarjaji*), where dwarf scrub of genus *Barleria* (*socha*) and *Indigofera spinosa* (*likitagesi*) grow.

The Sambururand has rich fauna. There are large herbivores such as giraffe, elephant, buffalo, oryx, Grant's gazelle, impala, Grevy's zebra, and many carnivores

such as lion, cheetah, caracal, lycaon, hyena, jackal, etc. There also live several primates such as Anubis baboon and savanna monkey.

The Samburu, living in the arid central north Kenya, are specialized in pastoralism, and depend on their livestock, such as cattle, goat, and sheep. The population of the Samburu is estimated about 58,000 according to the 1978 census (Kenya Population Census, 1978). Most of them live in the Samburuland, which is administratively called the Samburu District. The language spoken by the Samburu belongs to the Eastern-Nilotic (Gregersen, 1977). This language is similar to the Maasai language (Spencer, 1973), and there are many other cultural elements which are common between the Samburu and the Maasai.

The Samburu depend on the products of livestock such as milk, blood, and meat. They also depend much on maize meal. Among these food items blood and meat are not regularly used. Therefore, the Samburu diet is mainly made up of milk, and maize meal.

Although the Samburu depend much on maize meal, they are not engaged in agriculture at all. They buy maize meal, sugar, tea, and so on from the outside with money which they earn by selling their livestock (mainly small stock). Wild animals are seldom hunted. Among the rich fauna of the Samburuland they regard only a few species as food such as buffalo, giraffe, and antelopes. They eat neither other mammals nor any of fish, birds, or their eggs.⁽¹⁾ Gathering is seldom conducted either although children often gather and eat fruits, roots, resin, and so on while herding livestock. Wild animals and plants occupy only a small proportion in the Samburu diet. All the subsistence activities of the Samburu are confined to those for maintaining and increasing their livestock. In short, the Samburu are specialized in pastoralism.

The Samburu keep five livestock species: cattle, goat, sheep, camel, and donkey. Among these, donkeys are only used as pack animals. The products of donkeys, such as milk and meat, are not used at all. They are not used for riding either. It is the products of the other four livestock species that the Samburu depend on.

One family usually keep several kinds of animals. Among the 54 Mabati families, 47 (87.0%) families were keeping cattle; 53 (98.1%) families were keeping small stock; 11 (20.4%) families were keeping camel. From these figures we can point out the following tendencies:

- (1) Almost all families keep at least small stock herd,
- (2) Most family keep a cattle herd,
- (3) A few family keep camel herd.

It is cattle and small stock (goats and sheep) that support the Samburu life. Camel is not a common animal, although in the more arid area, percentage of camel owning families and its herd size increase.

The Samburu live in a settlement (*nkang'*, pl. *nkang'ite*), which is surrounded by a 2–3 m high fence constructed of *Acacia* and *Commiphora* branches. The diameter of a settlement is about 50 m. The average settlement is composed of four independent families living in six or seven huts (Spencer, 1973). Each family in a settlement usually construct family kraals for their herd. The kraals (*sum*, pl. *sumi*) are con-

structed separately for small stock, for calves, and for donkeys. The family kraals are located in the center of the settlement, and huts (*nkaji*, pl. *nkajijik*) are distributed around these kraals. Cattle are moved into the remaining area inside the settlement enclosure (*uata*, pl. *uatan*), where they too spend the night. Adult and infant camels are penned in separate family kraals.

II. Social Background of the Samburu

The Samburu society is characterized by both the age system and the patrilineal descent system.

The Samburu age system is a combined system of the age-grade system and the age-set system. There are three major age-grades for the male. These are the boyhood (*laiyok*, pl. *laiyoni*), the youth or the warrior (*lmurran*, pl. *lmurran*), and the elderhood (*lpaiyan*, pl. *lpaiyani*). A man belonging to the youth age-grade is generally called a moran. The elderhood is divided into four sub-age-grades: the junior elderhood, the middle elderhood, the senior elderhood, and the retired elderhood. A boy about 15 years old is circumcised and becomes a moran. All the men who receive circumcision within a specific period of about 12 years, which proceeds from the beginning of the age-set concerned, form one independent age-set. Each age-set has a special name, and the members never change the affiliation to their age-sets through their life. In 1986 there were six age-sets, named Limericho, Likileko, Limekuri, Likimaneki, Likichili, and Likilolo in descending order. Only Likilolo age-set occupied the youth age-grade. The other five age-sets belonged to the elderhood. Among these, Likichili was the junior elders, Likimaneki was the middle elders, Limekuri was the senior elders, and both Likileko and Limericho were the retired elders. The age-grade of the female is divided roughly into the girlhood (*ntito*, pl. *ntoie*) and the married women (*npartut*, pl. *ng'olio*) age-grade. Women do not form independent age-sets, and they are treated as members of the same age-sets as their husbands.

The second characteristics of the Samburu society is the patrilineal segmentary descent system. All the Samburu are divided into two moieties named the Black Cattle (*Ngishu narok*) and the White Cattle (*Ngishu naibor*). Each moiety is divided into 4 phratries (*Imarei*, pl. *Imareita*). These phratries except for one named Masola are the units of exogamy. Each phratry is segmented into several subgroups, which Spencer (1965: 74) calls clans, and again each clan is segmented into several subgroups, which Spencer (1965: 74) calls sub-clans. The Samburu call both clan and sub-clan as *ntepat* (pl. *ntepati*), and they distinguish the former as *ntepat kitok* (big) and the latter as *ntepat kini* (little), if necessary. Each phratry, clan, and sub-clan has its own name (Spencer, 1965: 72–73).

DAY-TRIP HERDING OF THE SAMBURU

I. Herd Formation

A polygynous family, a married man and his wives and non-married children, is the minimal social unit in the Samburu society. In Samburu, it is called *ltim* (pl. *ltime*), "the gate of the settlement." In principle, livestock owned by one such family is herded together in the daytime and is kept in one definite kraal at night.

From the whole livestock owned by one family, several pastoral herds are formed according to the species and age of livestock. Each large stock species, such as cattle (*ngiteng'*, pl. *ngishu*), camel (*ndames*, pl. *ndamesi*), and donkey (*sikiria*, pl. *sirkon*), is herded separately. Small stock species, such as goat (*nkine*, pl. *nkineji*) and sheep (*nkerr*, pl. *nkerra*), are herded together (in Samburu, small stock are collectively called *ntare*). Within each species except for donkeys, infants are separated from adults. In short, seven kinds of pastoral herds are formed within one Samburu family in case there are all livestock species; an adult cattle herd, a calf herd, an adult camel herd, an infant camel herd, an adult small stock herd, an infant small stock herd, and a donkey herd. In the daytime, each of these herds except for an infant small stock herd and a donkey herd are herded by respective herders, and at night, each herd is enclosed in different kraals. An infant small stock herd and a donkey herd are herded around the settlement without any definite herders.

In case a pastoral herd becomes too large, or in case the distance of a herd's travel for one day becomes too long in the severe dry season, the adult herd is usually divided into two separate pastoral herds. In such a case, yearlings, who are inferior to adults in the ability to move, are separated to form another pastoral herd called *laram*. In case there are few calves and the number of herders is not large enough for maintaining all kinds of pastoral herds separately, calves and adult small stock are herded together.

In this paper, goats under about six months old, which are observed to drink their mother's milk, are called kids. Kids are separated from the adult herd, and herded around the settlement without any specific herder in the daytime. They are permitted to contact with their mothers only twice a day at the milking time in the morning and in the evening. In the nighttime, too, they are enclosed in a different kraal from their mothers'. Lambs, infants of sheep, are treated just in the same way as kids except that they are enclosed in the kraal of their mothers' in the nighttime. Lambs are able to drink even at night, and so lambs grow more quickly than kids. The informant explains the reason as follows: The Samburu enclose lambs and ewes together at night, because ewes cry all night. However, this reasoning seems doubtful, because pastoralist such as the Turkana is known to separate lambs even at night (Ohta, 1982), and the other reason is not certain.

II. Seasonal Patterns of Herding Activity

In the rainy season and the following few months, the settlement is the base for

day-trip herding, and all kinds of pastoral herd are managed around the settlement. But in the dry season, when the area around the settlement is dried up, livestock are moved to stock camps. A stock camp is surrounded by a fence constructed of thorny branches. The kraals for the infant herd is constructed in the central part of a camp, and the adult herd is moved into the area between this kraal and the camp enclosure. The difference between the settlement and the stock camp is that there are no married women and so no huts in the stock camp. Herders enclose small area in the camp by logs and branches, and burn a small fire at the entrance. They take meals and sleep there in the open.

When and where the stock camp is built depends on the conditions of grass and water. It varies from place to place, and from year to year. The seasonal movement pattern varies according to livestock species just like among the Turkana (Ohta, 1980). The cattle, which is the weakest against the dryness, is moved to the stock camp from the earliest to the latest. The small stock, which is considerably strong against the dryness, is usually kept in the settlement even after the dry season has become intense. The camel, which is the strongest of all against the dryness, is kept even after the small stock herd has moved to the stock camp.

Thus we can classify the seasonal patterns of herding activities of the Samburu as follows:

(1) The rainy season pattern

There is abundant grass and water around the settlement. All livestock species are herded around the settlement.

(2) The moderate dry season pattern

There is a little grass and water around the settlement. The cattle herd is moved to the stock camp, though the small stock herd is kept in the settlement.

(3) The severe dry season pattern

There is almost no grass and little water around the settlement. Both the cattle herd and the small stock herd are moved to a stock camp. Sometimes the settlement itself moves to a better place.

III. Herding Route

There is no regular route of the day-trip herding of goats among the Samburu. In case the environmental condition is too bad, the area which pastoral herds can use is strictly confined, the herding route consequently gets fixed. Except for such cases, the herding route in the Samburu is not fixed. Figure 3 shows an example of the herding routes. I took this data by interviewing the herder of one goat herd from December 8 to 24 in 1984, whose family, named Leronyokie, was in the same settlement with Simion then. On 10th and 20th he answered that the herd went to "Salapani," where I could not identify. The herding routes fluctuate widely in a short period.

The major causes which determine the herding route are the distribution of food plants and the location of the watering place. In the rainy season when there is abundant grass around the settlement, and consequently the herding distance in a day is

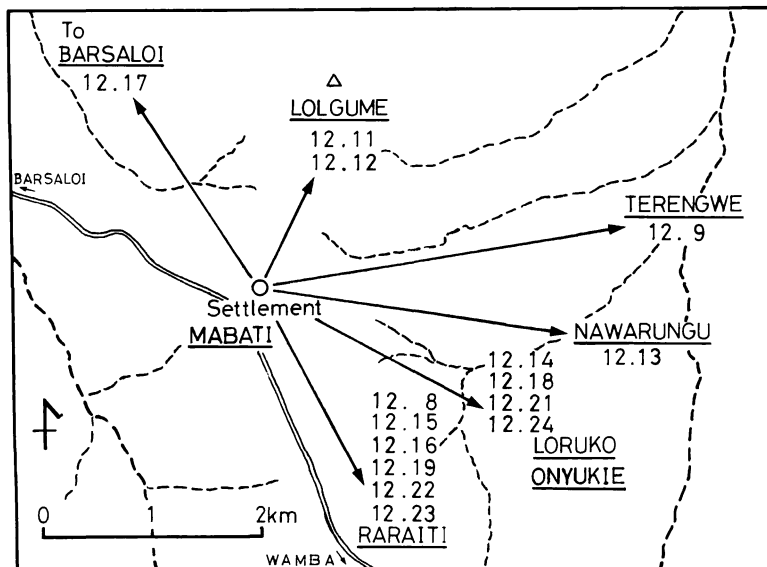


Fig. 3. Changes in the route of day-trip herding of a goat herd during December 8-24, 1984.

short, around 5 km, goats usually come back to the settlement in the afternoon for taking a rest in the shade of one accustomed tree just outside the settlement. In this season goats are not taken to water nor to lick salt at all. In a short period after rainfall, an *Acacia* species called *iti* (*Acacia mellifera*) blooms in the woodland. Goats like this white blossom called *tapokai*, and they are herded mainly in the woodland in this *tapokai* season. After this season, another *Acacia* species called *Itepes* (*Acacia tortilis*) bears abundant pods called *sagaram* in the riverine forest. In this season goats are herded inside of the riverine forest in order to take *sagaram*.

In the moderate dry season when the area around the settlement becomes dry, goats travel a longer distance a day in search of food plants. Goats are usually watered every 6–7 days, and cattle are watered every two days in this season. On the small hills and mountains there remain food plants for livestock later than in the lowland. The Samburu do not use such places until the environmental conditions become worse in the dry season.

In the severe dry season when the area around the settlement dries up, livestock except for the camel are ordinarily moved to the stock camp. Goats are watered every three days, and the cattle is watered every day. In this season, the daily herding distance for goats exceeds 10 km.

IV. Daily Activity Pattern of Herding

Although the base of the day-trip herding changes from the settlement to the stock camp according to the season, the daily activity pattern of the pastoral goat herd

does not change. This section describes the typical daily rhythm of the pastoral goat herd.

About 7:30 a.m. the first wife opens the gate of the kraal of goats, and the wives and daughters begin to milk. After they finish milking, they take kids out of the small kraal, and kids drink the remainder of milk. Kids are put again in their kraal after drinking. Other goats are foraging or taking a rest around the settlement.

Around 8:00 a.m. the herder gathers goats, and the herd begins to move.⁽²⁾ After moving in several lines for a while, goats disperse a little and begin feeding. They move and feed slowly until around midday, when goats stop feeding and gather in the shade of a suitable tree. After taking a rest for 2–3 hours they begin feeding again. Until about 6:00 p.m., when the sun sets, they continue to feed and move slowly bound for the settlement. Thus I could distinguish three phases on the activity pattern of the pastoral herd; the moving phase when the goats only move in several lines, the feeding phase when they feed dispersing a little and moving slowly, and the resting phase when they gather in the shade and rest. The day-trip herding of the pastoral herd consists of these three phases, i.e., these three phases turn one after another in a day.

Kids are let loose about half an hour after the adult herd's departure, and they feed by themselves around the settlement. They are put in their enclosure again just before the adult herd returns in the evening.

As soon as the adult herd comes back to the settlement, the wives and daughters begin milking again. After milking in the evening kids are put in the small kraal for them, and all adult goats are admitted into their kraal. The wives count their goats. After they make sure that all goats are back, the first wife close the gate of the goats' kraal.

This activity pattern is a typical one, but in case there is abundant grass around the settlement or the stock camp, the livestock begin to feed before sunrise. After feeding until 8–9 a.m., the livestock come back to the base and milked. And after taking a rest for 1–2 hours, they go to feed again. The Samburu calls the early morning herding *rimo*.

MATERIALS AND METHOD

The research is conducted in three periods: from July 1982 to February 1983; from July 1984 to March 1985; and from September 1986 to February 1987. I conducted a research mainly in the area around Barsaloi in the central lowland. In the first and second research periods I stayed at Mabati, and in the third period at Suiyan. In September 1984, there were about 400 persons of 54 families, and they were dispersed in 16 settlements at Mabati. Among them, about 150 persons were adults such as morans, elders, and married women.

One elder named Simion Lesiameto assisted me both as an informant and as an interpreter. Simion, aged about 35 then, is a member of Likichili age-set, and belongs to Lparsiyomo sub-clan of Lmakarit clan of Lorogushu phratry. In 1987, he had 2

wives and 5 children; 4 by his first wife, and 1 by his second wife. His father was dead already. He had one elder brother, who also belongs to Likichili age-set, and one younger brother, a member of Likilolo age-set. These brothers lived with their mother at Suiyan.

The homestead of Simion was at Mabati in 1982 and 1984. I stayed in his homestead, and made participant observations on the activities of his family. The object of this study was the small stock herds of Simion and those of James Lekumato, a friend of Simion. Cattle of Simion and those of his brothers' were herded together by his younger brother, who was a moran. Small stock of these three brothers was also herded together at Suiyan at first, but in October 1982, a part of Simion's small stock herd was brought to Simion's settlement at Mabati. Camels of Simion was herded by a member of the same sub-clan as Simion.

James Lekumato, about the same age as Simion, also affiliates to Likichili age-set, and is a member of Saale sub-clan of Lokumai phratry (the name of his clan and that of his phratry are the same one, and the difference between them is not clear). He had one wife and three children. He was an assistant of the church at Mabati, and earned some money from there. He lived in a log cabin near the church. He owned a small stock herd only, and made an enclosure for his herd in Simion's settlement from October 1982.

Although goats and sheep were herded together in Samburu, I call these small stock herds as "pastoral goat herds," for the number of sheep of these herds was small, and I confined my observation to goats' behavior. In 1982 the pastoral goat herd of Simion was herded by a girl of about 13 years old, who was a daughter of an old man named Lewuas (Likileko age-set) living in the same settlement with Simion. The pastoral goat herd of James was herded by a girl of about 18 years old, who was a younger sister of James' wife.

I distinguished all individual goats of these two pastoral herds by several characteristics such as age and sex, color and pattern of coats, and shape and size of horns, etc. The age-sex composition of these two herds are shown in Table 1, and the information on each goat of Simion's herd is shown in Table 2.

Table 1. Age-sex composition of the study herds.

Category of goat	Number of goats	
	Simion's herd	James' herd
M: Reproducing male	1	1
C: Castrated male	3	2
m: Matured male not castrated	1	1
Y: Young male	8	11
F: Parous female	17	24
f: Matured nulliparous female	1	3
y: Young immature female	7	7
I: Infant male	4	2
i: Infant female	5	4
Total	47	55

Table 2. Information on each goat of Simion's herd.

Goat	Category	Age	Fluctuation	Goat	Category	Age	Fluctuation
1. A1	F	3+		26. H11	I	0	B 1982. 9
2. A11	I	0	B 1982. 7	27. H2	Y	1	
3. B1	F	3+		28. I1	F	3+	
4. B11	f	3		29. I11	I	0	B 1982. 9
5. B12	i	0	B 1982.10	30. X1	M	3	
6. C1	F	3+		31. X2	C	3+	enter
7. C11	i	0	B 1982. 9	32. X3	C	2	enter
8. D1	F	3+		33. X4	Y	1	enter
9. D11	F	3		34. X5	Y	1	enter
10. D111	y	0	B 1982. 6	35. X6	Y	1	enter
11. D12	F	3+		36. X7	Y	1	out*
12. D121	i	0	B 1982.10	37. X8	m	2	enter*
13. E1	F	3		38. X9	C	?	out*
14. E11	Y	0	B 1982. 6	39. X10	Y	1	enter*
15. F1	F	3+		40. x1	y	1	
16. F11	F	3+		41. x2	F	3	
17. F111	i	0	B 1982. 6	42. x3	y	1	enter
18. F12	y	1		43. x4	F	3+	
19. F13	I	0	B 1982.10	44. x5	F	3+	
20. F2	F	3+		45. x6	y	1	enter*
21. F21	Y	1		46. x7	y	0	enter*
22. F22	i	0	B 1982. 6	47. x8	y	0	enter*
23. G1	F	3					
24. G2	F	3+					
25. H1	F	3					

For the symbols of goat categories, see Table 1.

Age of goat was determined by teeth examination in January 1983. Goats which had already developed two teeth of the second set were classified as 1 years old; four teeth as 2 years old; six teeth as 3 years old; 8 teeth as more than 3 years old.

Goats of matrilineal kin relation constitute a family. The families are symbolized by letters, A, B,...I. The goats with the symbol X (for male) and x (for female) have no kin related goats in the study herd. Kin relation among goats in a family are indicated as follows: (1) A1, A2, A3,... are siblings, the goats with lower numbers being older, (2) A11 A12,... are A1's offspring, with older offspring having lower numbers.

B: birth; *: entered or out during December 1982 to January 1983.

I followed day-trip herding of the object pastoral goat herds from October 1982 to February 1983 and observed and recorded the behaviors of the herders and goats.

RESULTS

I. Interaction between the Herder and the Goats

This section describes how the Samburu do the day-trip herding of goats for understanding how the herder interacts with goats while day-trip herding.

The herder acts on goats in such manners as shouting, throwing a branch or a stone near the goat, and whipping by a stick or a twig. The reaction of the goat is the same regardless of the herder's action. The goat shows a kind of submissive behavior for a moment, turns the direction and moves a little, and begins to feed again.

This reaction is different from that against the carnivorous animals, but similar to that of a subordinate goat who is butted by a dominant goat.

When we observe the reaction of a whole pastoral herd, we can read the intention of a herder. According to my observation, there are three aspects in the herder's herding behavior; integration, leading, and turning the phases.

Integration is to return goats who are away from the pastoral herd. In such cases the object of the herder's herding behavior is an individual or some individuals away from the pastoral herd.

Leading is to turn the direction of the pastoral herd's moving. In such cases the object of the herder's herding behavior is some individuals or a small party at the head of the pastoral herd.

Turning the phases is to change the phase of a pastoral herd's activity such as the moving phase, the feeding phase, and the resting phase. This is achieved in the following manner. The herder puts a kind of pressure on the pastoral herd in the moving phase by shouting "che" or "hai," by whipping sometimes, or by walking a little fast by the side of the pastoral herd. When he stops putting such pressure, goats begin feeding when they are hungry, or they begin resting when they are full.

However, when we more precisely observe the interaction between the herder and the goats, we can understand that the herder controls the direction and the speed of the herd's movement.

The herder controls the direction of the herd's movement not only by leading, but also by integration. That is, the herder usually integrates in order to eliminate unintended herd's movement in the bud. The herder does not integrate such individuals that are left in the rear of the pastoral herd, because he/she knows such individuals come back to the pastoral herd by themselves. I observed that a goat which was lost and bleating in the woods came back to the pastoral herd only by the herder's answering "o" to the goat's bleat. The herder mainly integrates goats not only when they are moving in an unintended direction, but also when he anticipates the rest of the pastoral herd might follow. In such a case, the primary concern of the herder is not to avoid the pastoral herd's splitting into two parties but to lead the pastoral herd in the intended direction.

The turning the phases controls the speed of the herd's movement. The speed of the herd movement becomes faster by putting pressure on the pastoral herd, or it becomes slower by stopping to put pressure on the pastoral herd. When the pastoral herd moves too fast, all the goats can do is to follow the pastoral herd and they cannot feed. This phase is the moving phase. On the other hand, when the pastoral herd moves slowly enough, each individual can feed as it follows the pastoral herd. This is the feeding phase. Thus the herder can turn the phases of the pastoral herd by controlling the speed of the herd's movement.

In short, the herder is controlling the direction and the speed of the herd's movement.

As mentioned above, the day-trip herding consists of three phases, i.e., the moving phase, the feeding phase, and the resting phase. Except for the resting phase when the herder does not control the herd at all, the herder does the herding behavior and

controls the herd in other two phases. In the moving phase the herder frequently controls the herd, and it is suggested that the moving phase is maintained by the herder's intervention. The problem is that how much the herder does the herding behavior in the feeding phase, and how the feeding phase is maintained.

On January 27, 1983, I took data on how much a herder does herding behaviors from 8:19 a.m., the time of departure, till 12:10 p.m., when goats began resting (Fig. 4). From 8:19 a.m. to 8:25 a.m. and from 11:27 a.m. to 12:10 p.m. goats were in the

Distribution of control	Time (a.m.)	Types and time of control
→	8:30	beginning of feeding phase (8:25)
→→		# (8:26) # (8:33), ★ (8:34)
→	9:00	☆ (8:54)
→→→		☆ (8:56), ☆ (8:58), ☆ (8:58)
→	9:30	○ (9:11)
→		○ (9:17)
→	9:30	○ (9:30)
→	10:00	☆ (9:56)
→→	10:30	# (10:38), # (10:38)
	11:00	
→→→→	11:30	★ (11:17), ★ (11:18), ★ (11:18), ★ (11:18) beginning of moving phase (11:27)

Fig. 4. Distribution and types of a herder's control over the goats and sheep in the feeding phase (January 27, 1983). →: one unit of control. Types of control over the goats are classified into two categories: integration and leading, and the latter is sub-divided into two: control of speed and direction of moving. ★:integration, ☆: speed, ○:direction, #:control over the sheep.

moving phase, i.e., they moved in several lines and did not feed at all. The pastoral herd were feeding from 8:25 a.m. to 11:27 a.m. for 182 minutes. I counted the herding behavior every 10 seconds as 1 unit, so this 182 minutes came out to be 1092 units. The herder's intervention to goats were observed only in 14 units (1.28%) in this feeding phase. Of these 14 units, 6 units (0.55%) were integration and the other 8 units (0.73%) were leading. Although the pastoral herd was feeding in the woods on a gentle slope, the pastoral herd moved as a coherent aggregation receiving only 6 units (0.55%) of integrative interventions.

II. The Unity of the Pastoral Goat Herd

The fact that the quantity of herder's intervention being very small suggests that pastoral goats have a tendency to gather for themselves. This section clarifies how the unity of the pastoral goat herd is maintained by goats themselves through my observations.

Following a goat in the feeding phase, I often observed that a goat, after eating grass with putting its face close to the ground, raises its neck and gazes at the front with its ears erected. Goats show this behavior when an individual or some individuals are apart from others. In case goats are more than 20 m apart from the nearest, they run and join the pastoral herd (Shikano, 1984). I often observed that members of a small party in the rear of the pastoral herd made this kind of behavior and join the pastoral herd without receiving any herder's intervention.

When an individual goat became separated from the rest of the pastoral herd, it took the "alarm posture" (Shank, 1972), raising its stiffened neck and curling its back, and it ran around bleating. As soon as it could join the pastoral herd, it began feeding again calmly. I define this kind of behavior as the "herd-oriented behavior." The herd-oriented behavior was seldom observed because the herder intervenes before goats would show this behavior. I, however, observed a small party of 2, 3, and 8 individuals showed this behavior (Shikano, 1984).

The preceding observations show that the unity of the pastoral goat herd is maintained primarily by the goat themselves. The pastoral goat herd is a stable group, and the herder only assists goats in gathering together. The goats are herded by a small amount of the herder's intervention.

In my observation, there was no specific individual that was always in the front of the pastoral herd. Nor was observed such an individual that took an integrating behavior, such as calling to a lost individual. In short, there was no "leader" in the pastoral goat herd.

It is evident that there is a dominant-subordinate relationship between goat individuals. As a rule, the bigger is the individual, the more dominant it is. This dominant-subordinate hierarchy between two individuals is observable as the dominant butts to the subordinate.

Between females, however, this butting was rarely observed. Along with the focal animal sampling, I also conducted the ad-lib sampling. I observed butting between females only once in 1198 samples.

Male goats are known to conduct a ritual clash, and the dominance hierarchy between males is determined by the issue of the clash. The dominance between males, however, is a sexual dominance; the dominant has the priority of access to an estrus female. Butting between males was seldom observed in the feeding phase. I did not observe it at all while conducting the focal animal sampling. A dominant male was not observed to occupy a food patch, but observed to feed together with others in one small food patch. In short, it is difficult to conclude that the pastoral goat herd is based on the dominance hierarchy.

Thus neither the leader system nor the rank system contributes to the integration of the Samburu pastoral goat herd. The herd-oriented behavior shows that the unity of the pastoral herd is maintained by such mechanism as each individual member consisting the pastoral herd follows its herd.

III. Proximity Relationships among Goats

I collected data on the proximity relationships between goat individuals by the focal animal sampling. I followed the focal animal, that is selected randomly, and recorded the individuals that were present within the radius of 1 m, 3 m, 6 m, and 12 m around the focal animal every 3 minutes. A total of 1198 samples were collected.

I collected these data from December 1, 1982 to January 28, 1983 in the moderate dry season. Since the quantity of milk became too small, people quitted milking in this period. The kids, which are usually separated from the adult herd, were herded together with adults.

Kimura (1987) devised a graph called "Inter-individual Perspective (IP) Graph," which shows an individual's perspective on the degree of the proximity with other individuals. The index which shows the degree of proximity of an individual-Y for a focal animal-X is taken on the vertical axis of the IP Graph. The index is calculated as follows:

$$I_x(Y) = N(X \cap Y) / N(X)$$

where

$I_x(Y)$: the index of X with respect to Y

$N(X \cap Y)$: the number of quadrates in which both X and Y were observed.

$N(X)$: the number of quadrates in which X was observed.

This index ranges from 0 to 1, and the value nearer to 1 shows that Y is in a closer proximity to X. On the horizontal axis of the IP Graph the individuals are arranged in descending order of the index, and the graph connects these values.

In this way I described the IP Graphs for 21 females and 9 kids of Simion's herd, which show the proximity relationships between these females and kids. The details of these females are described in Table 3, i.e., eight parous females with no kids in the herd, four nulliparous females, and nine parous females with kids.

Concerning the IP Graph of one individual, the four IP Graphs which correspond to four kinds of quadrates around the focal animal, i.e., the radii of 1 m, 3 m, 6 m,

Table 3. Focal animals whose proximity relation with other goats was examined.

Category	No. of goats
Parous female without kid	8
Parous female with kid in the same herd	
Its kid was not weaned yet	6
Its kid was already weaned	2
Its kid was present in the same herd, but the mother could not identify it	1
Nulliparous female	4
Infant	
Not weaned	6
Weaned	2
Not weaned, but the mother could not identify the kid	1
Total	30

and 12 m, can be described. However, these IP Graphs of one focal animal come out to be the same type, so I only show the IP Graph of 6 m radius in the following analysis.

Regarding the shape of these graphs for 30 individuals, I can classify them into the following three types (Fig. 5):

(1) Exponential Function Type

It is suggested that the focal animal has a tendency to be in a closer proximity with several specific individuals.

(2) L-Shaped Type

This type is interpreted as the extreme exponential function type, and the focal animal shows a very close proximity with one specific individual, but no selective proximity with the others.

(3) Linear Type

There is suggested to be no selective proximity between the focal animal and the others.

All of the IP Graphs of eight parous females with no kids in the herd are linear type ones. I averaged these graphs and show it in Figure 6. All IP Graphs of four nulliparous females are linear type ones, too. I averaged these graphs in Figure 7. This suggests that the proximity relationships of these individuals to others are not selective. In case of nulliparous females F11 and B11, whose mothers were in the same herd, the proximity between these individuals and their mothers are not selective ones.

There were nine parous females with their kids in the same herd in the study period. Of these nine, first of all, there were six females whose kids were not weaned. The averaged IP Graph of these individuals are shown in Figure 8. All IP graphs of these six individuals are L-shaped type ones, and the index of their kids are the highest value in all cases. In short, these six females are in the selective proximity with their kids alone, and except for these relationships, there is suggested to be no selective proximity with other individuals in the herd.

Secondly, there were two parous females whose kids had already been weaned then. The IP Graphs of these two individuals are shown in Figure 9. These linear

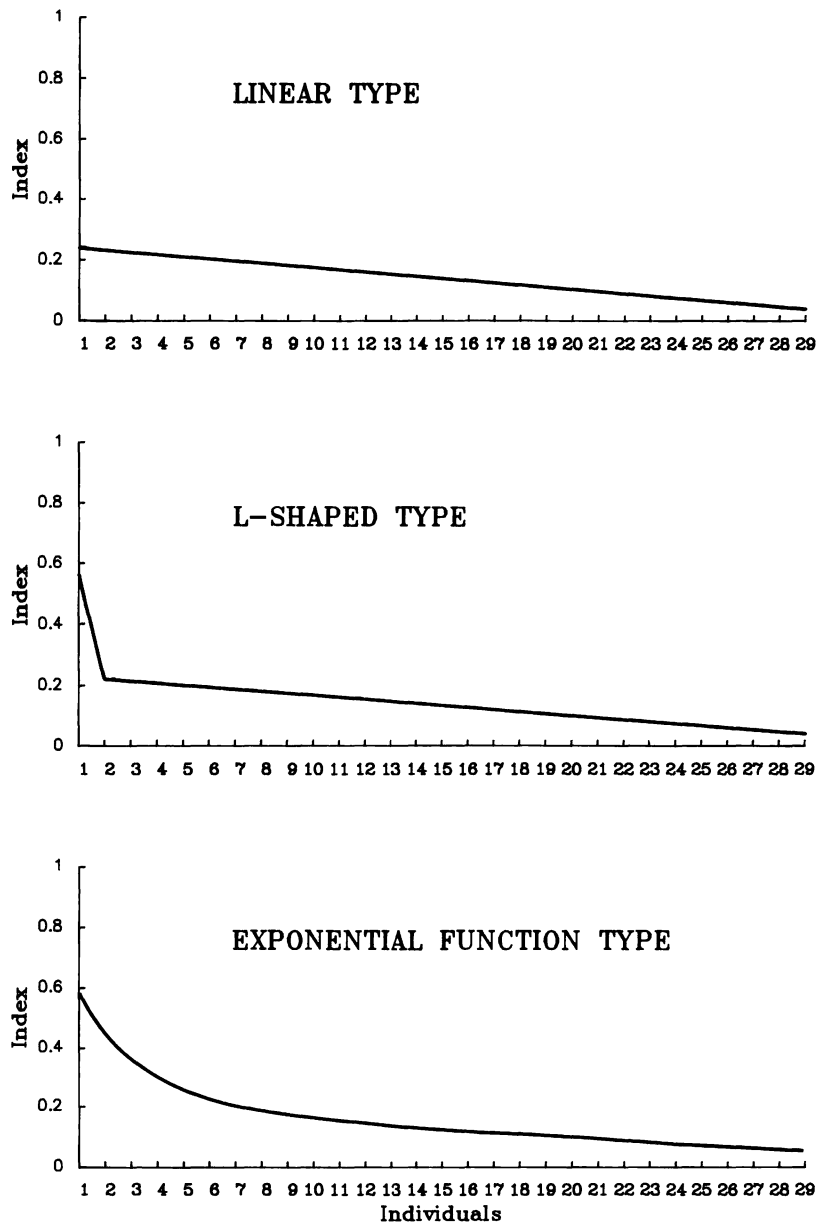


Fig. 5. Three typical types of IP Graphs.

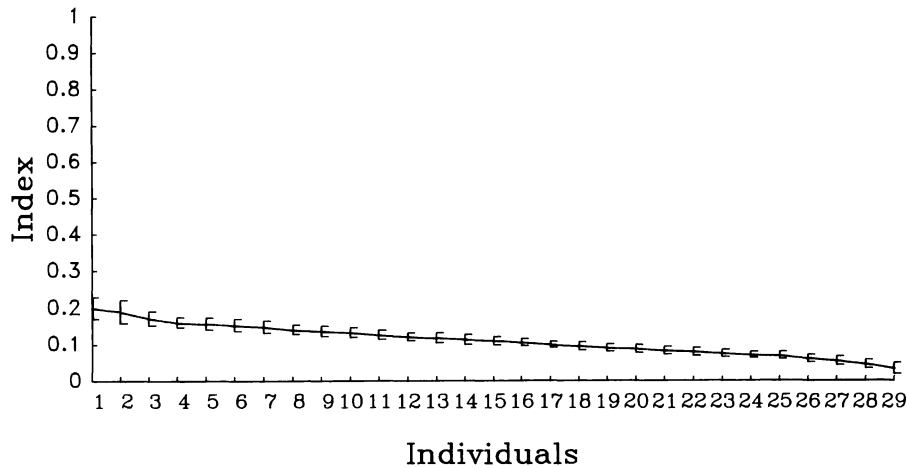


Fig. 6. IP Graph for eight parous females whose kid was not present in the same herd. For each category (the 1st goat which showed closest proximity to the focal animal, the 2nd, the 3rd... the 29th), index values of focal animals are averaged, and the standard deviations are indicated by [.

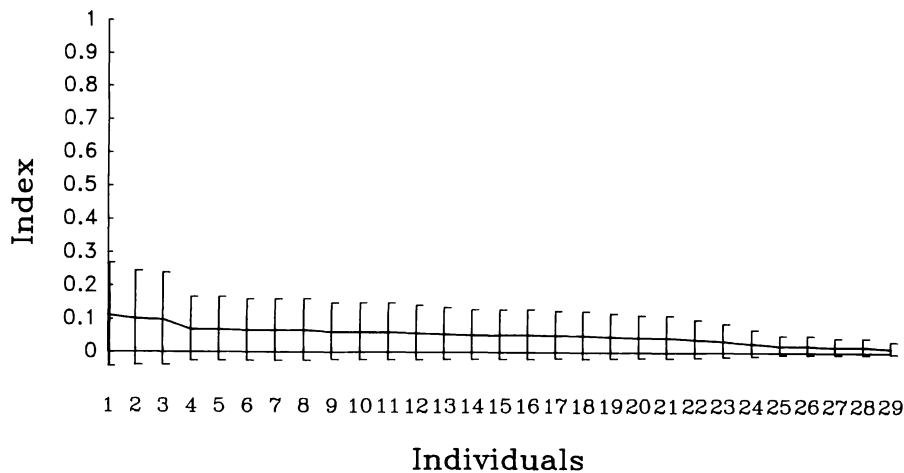


Fig. 7. IP Graph for four nulliparous females. For each category (the 1st goat which showed closest proximity to the focal animal, the 2nd, the 3rd...the 29th), index values of focal animals are averaged, and the standard deviations are indicated by [.

type IP Graphs show that there were no selective proximity with their kids. In other words, the relationship between mother and infant does not last with spatial proximity after kid's weaning.

Within nine parous females with their kids, the last one is I1. Although I1's kid, named I11, was about three months old at this study period, I1 rejected to give her

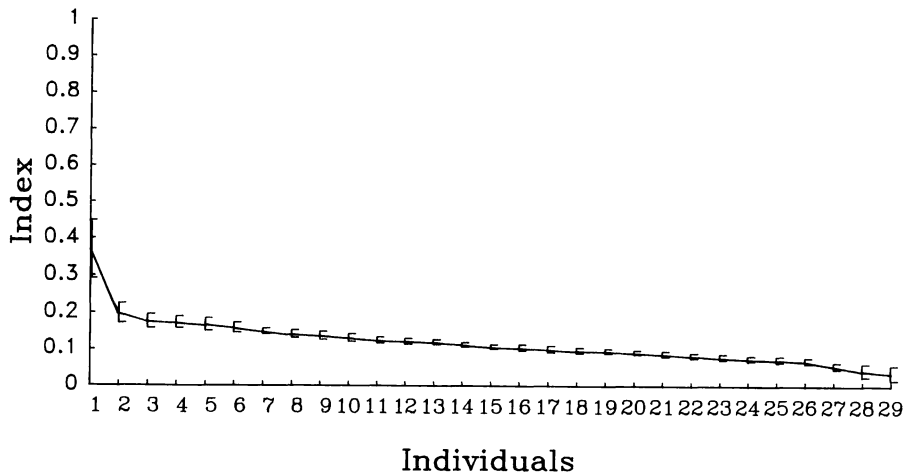


Fig. 8. IP Graph for six females whose kid was present in the same herd.

For each category (the 1st goat which showed closest proximity to the focal animal, the 2nd, the 3rd...the 29th), index values of focal animals are averaged, and the standard deviations are indicated by [].

milk to I11, and the herder gave some milk poured in a tin can to I11. From these observations it is suggested that the mother-infant recognition between these I1 and I11 was not established. The IP Graph of I1 (Fig. 10) is a linear type one as those of females without their kids, and there is no selective proximity between I1 and its infant.

Viewing what have been mentioned in the preceding paragraphs from the side of kids, I get the following results. There were nine kids in the study herd then; six kids were not weaned, two were already weaned naturally, and the remaining one with no established mother-infant recognition. The details of these kids are also shown in Table 3. Figure 11 shows the averaged IP Graph of six kids before weaning. This IP Graph is an exponential function type one. In these graphs the highest index values are of their mothers', that is, kids before weaning are in the strong proximity with their mothers. There continue several higher indices, because the focal kid was in the selective proximity with other kids. Figure 12 shows the IP Graphs of two kids already weaned, and the IP Graph of the other kid is shown in Figure 13. Although there are not observed selective proximities with their mothers within these graphs, they are exponential function type ones.

The IP Graphs of kids come out to be exponential function type ones, because there is observed a little bit strong proximities between several kids. To clarify the social relationships between kids, I tested the difference of frequencies between females' presence and kids' presence in the quadrates in which the focal animal, i.e., these nine kids, was observed (Table 4). In case of five kids, C11, D121, E11, H11, and I11, the difference is significant in any radii of quadrates, and it is suggested that there is a tendency for kids gathering together. [The IP Graphs of E11 and I11 are

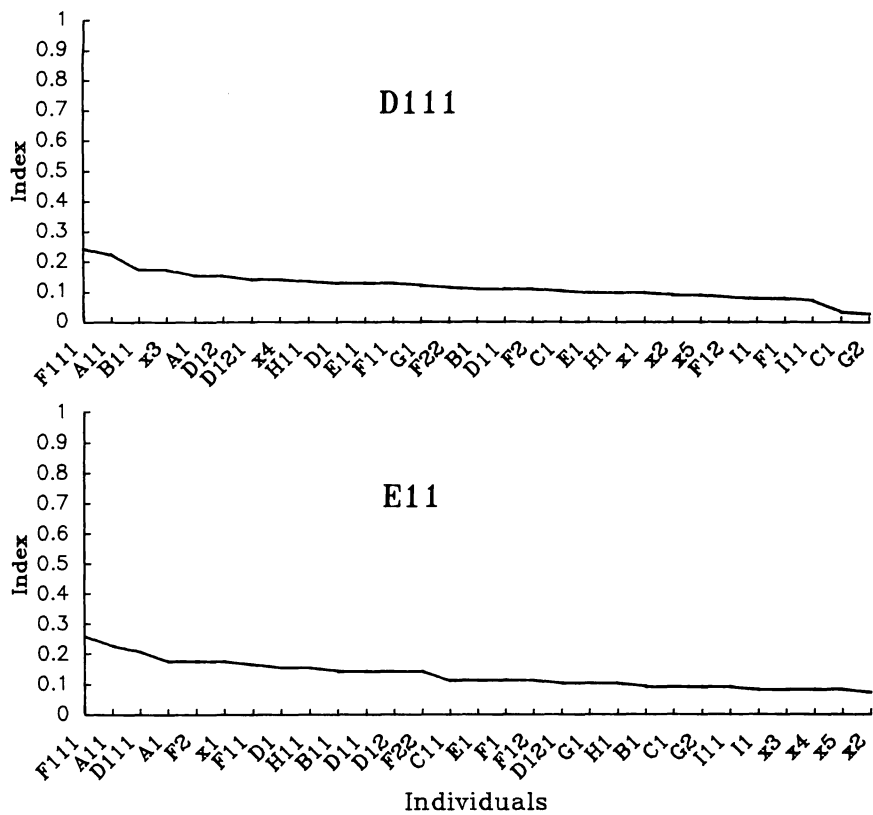


Fig. 9. IP Graphs of two females whose kids, which were already weaned, were present in the same herd.

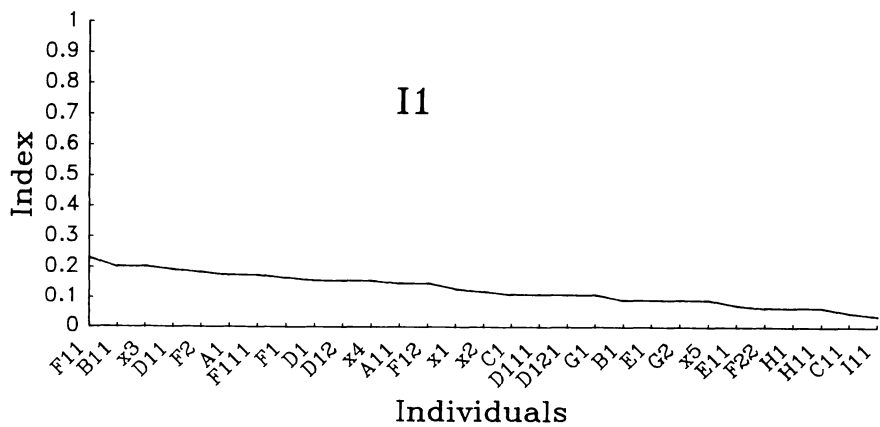


Fig. 10. IP Graph of a female who had a kid of three-months-old in the same herd, but could not identify it as its infant.

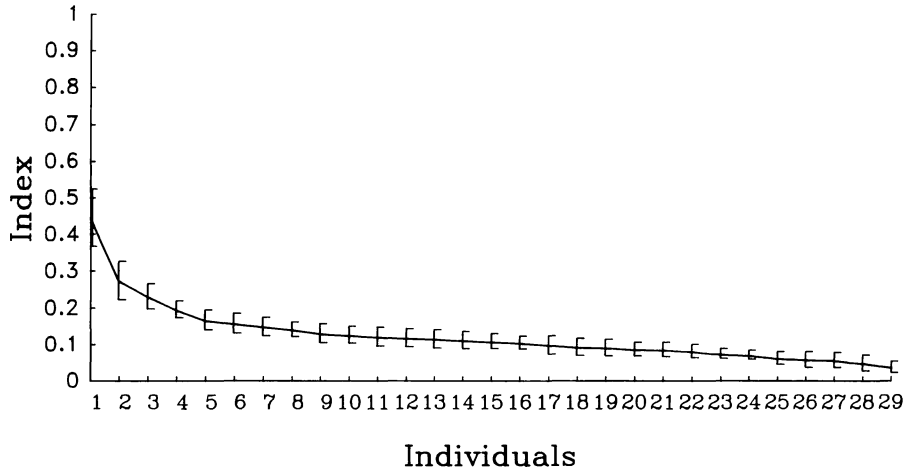


Fig. 11. IP Graph for six kids, which were not weaned yet.

Their mothers' proximity relations are examined in Fig. 8. For each category (the 1st goat which showed closest proximity to the focal animal, the 2nd, the 3rd...the 29th), index values of focal animals are averaged, and the standard deviations are indicated by [.

shown in Figures 12 and 13.] This result was derived from the fact that these five kids had a tendency to gather with one another. Other kids before weaning showed strong proximity with their mother but no selective proximity with other kids. These kids except for E11 were born almost in the same period, and I observed that these four kids were foraging in one party around the settlement, which was different from that of the party of other kids, before they were herded together with the adult herd. From this observation, it is thought that these kids established intimate relationships with one another in that period, and that these relationships were maintained after they were put in the adult herd.

In short, with regards to the proximity relationships between females and kids in the day-trip herding, we can conclude that there are only observed selective proximities between the mother and its kid before weaning, and between the kids. It is naturally concluded that there is no specific individual in selective proximity within the ordinary pastoral herd, for kids were separated from the herd. Even between the individuals in the kin relation there was observed no selective proximity in the ordinary herd.

IV. Relationship between Different Pastoral Herds

Within the pastoral goat herd in the feeding phase, there was no specific individual in close proximity, which shows that pastoral herd is not organized by the bonds between any specific individuals. However, this does not mean that goats do not distinguish other individuals at all. On the contrary, goats distinguish the members of their own pastoral herd from those of other herds. They do not show not only any aggressive behavior but also any herd-oriented behavior against the members of

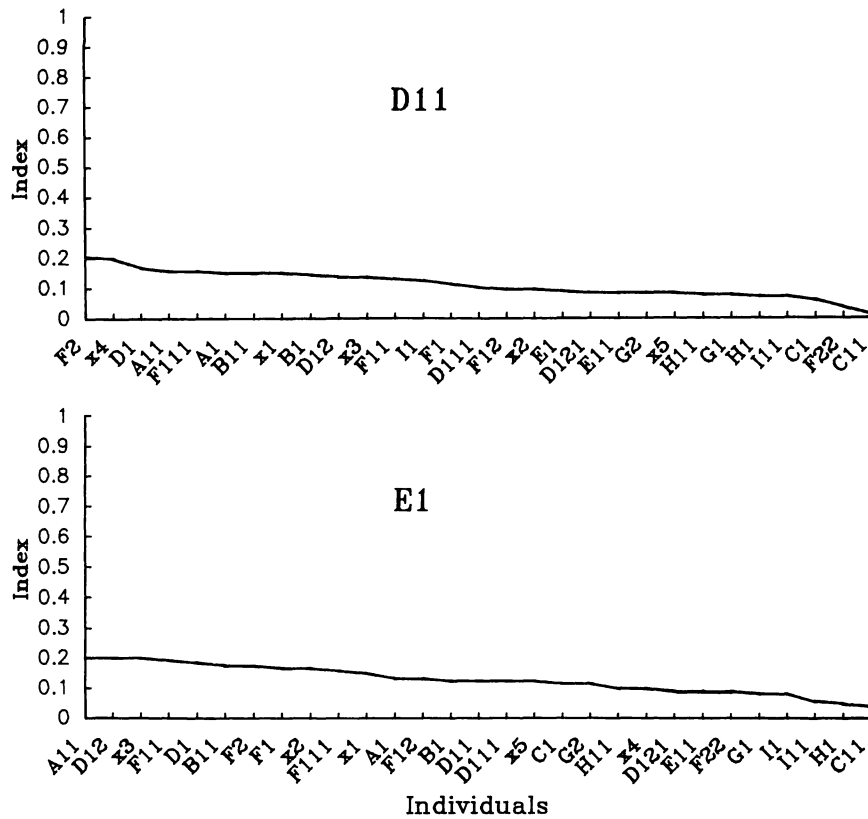


Fig. 12. IP Graphs of two kids, which were already weaned. Their mothers' proximity relations are examined in Fig. 9.

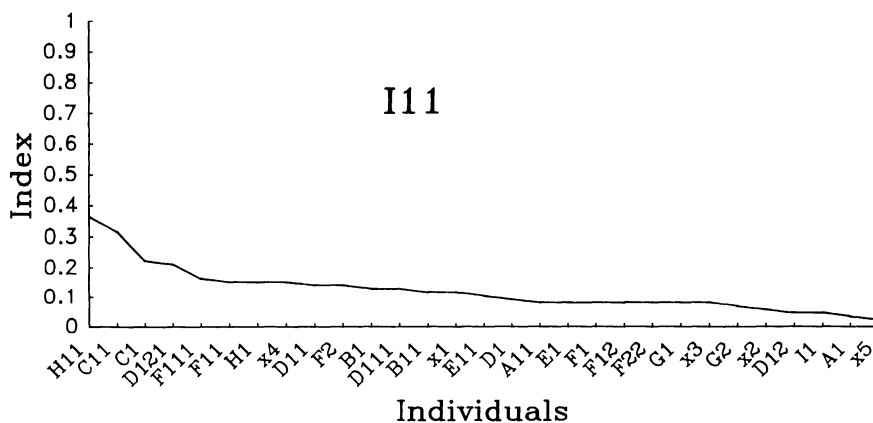


Fig. 13. IP Graph of a kid, whose mother was present in the same herd, but could not identify the kid as its infant (see Fig. 10).

Table 4. The difference in frequency between infants and females found around each focal infant (Mann-Whitney U-test).

Name of focal infant	Radius of quadrates							
	1 m		3 m		6 m		12 m	
	Infant	Female	Infant	Female	Infant	Female	Infant	Female
A11	88.5	79.0	75.0	93.0	65.5	102.5	61.0	107.0
C11	111.0	57.0	107.0	61.0	135.0	33.0*	122.0	46.0
D111	114.0	54.0	108.0	60.0	107.5	60.5	90.5	77.5
D121	137.0	31.0**	140.5	27.5**	122.0	46.0	110.0	58.0
E11	133.0	35.0*	129.0	39.0*	127.0	41.0*	106.5	61.5
F111	102.5	65.5	89.0	79.0	90.0	78.0	85.5	82.5
F22	87.0	81.0	100.5	67.5	88.5	79.5	83.5	84.5
H11	135.0	33.0*	141.5	26.5**	136.0	32.0*	124.0	44.0
I11	120.0	48.0	113.5	54.5	124.5	43.5*	130.5	37.5*

*Significant at $p < 0.05$, **Significant at $p < 0.01$.

other herds.

It was often observed that two goat herds came in close encounter while feeding. The goat herd in the feeding phase is not exclusive to the other herd, and any aggressive behavior is not observed on encounters. The herder tries to separate his herd from the other in principle, and it is rare that a herd mingles with the other. I, however, observed that two herds mingled, when two herds became completely mixed, and they separated again without any herder's intervention (Shikano, 1984).

I also observed that a small party of four goats, when they were left in the other herd after two herds' encounter, showed the herd-oriented behavior (Shikano, 1984).

From these observations it is concluded that goats distinguish their own herd from other herds, and that they show the herd-oriented behavior only to their own herd. In short, a goat herd has a unity as one discernible group.

I observed the behavior of a nulliparous female named x3 who was bought by Simion and was added into his herd. x3 was enclosed in the kraal together with the other members of Simion's herd in the first evening. In the next morning x3 was herded with the herd member. x3 often bleated. She ran to the other herd when she found it, and the herder intervened each time. In 3–4 days the frequency of such a behavior became lower and lower, and within one week x3 became herded just like the other herd members. This observation shows both that a goat recognizes its own (or another) herd and that the transfer between herds is easily achieved.

DISCUSSION

I. The Socio-Ecology of the Wild and Feral Goats

From the reports on the wild and the feral goats I could abstract the following characteristics in socio-ecology of goats (Shikano, in print): (1) Females are linked to their definite home ranges. (2) Males have a tendency to wander in wider areas. (3) Their natural herds are very flexible.

Among the feral goats on Chichijima Island of the Ogasawara Archipelago, which I observed in 1979 and 1980 (Shikano, 1982), females were moving within fairly small areas, the average home range size of 23 females was only 0.46 km². The degree of overlap of each female's home range clearly showed that females were divided into several sets of females whose home ranges were overlapping. Thus I could grasp this set of females sharing a common range as a female group. There were fairly overlaps between the common range of one female group and that of another, and some members of one female group sometimes made an expedition into a neighboring group's range. However, the core area which the members of one female group used intensively did not overlap at all. When the members of different female groups were encountered, no aggressive behavior between them was observed. However, the members of different female groups were observed less often in the same natural herd than the members of the same female group.

Among the male goats on Chichijima Island, most were moving in the ranges of more than two different female groups, while some were observed only in the range of one female group throughout the observation period. Thus it is concluded that the male goats have a tendency to wander in a wider area than females.

Goats in the range of one female group did not gather and form one stable group but dispersed and form several natural herds of 3–4 individuals (the average herd size was 3.8). In the process of ranging, these natural herds frequently mingled with another or separated into small natural herds. Moreover, through these mingling and separating process, it often occurred that the individuals once in the same natural herd might be observed in different natural herds on the next occasion. The natural herd of feral goats on Chichijima Island is an unstable group that does not have the unity of the group nor constant membership.

However, the bond between the mother and her infant, under 6 months old and often observed to drink the mother's milk, was the only stable pair within these natural herds. If the mother and infant should be separated during the fission of a natural herd, both individuals bleated towards each other and rejoined. Even this mother-infant bond was severed after approximately 6 months, when they were frequently observed in different natural herds.

The same observations as the feral goats on Chichijima are reported among the feral goats of New Zealand (Riney & Caughley, 1959). There, females, forming small unstable groups (averaged 3.8 individuals), move in a definite home range, while males move in a wider area.

According to Schaller, who observed the wild goats and sheep of the Himalaya, many females of wild goat (*Capra aegagrus aegagrus*) of Pakistan "spent their lives within an area of 20 sq. km, but some males possibly used two to three times as much terrain" (Schaller, 1977:178). Also he reported, "The herd structure of most species [wild goat, ibex, markhor, mouflon, urial, etc.] is similar, it being characteristically flexible, with only a mother and her young and sometimes a yearling as well, forming a close bond" (Schaller, 1977: 295; brackets mine). These observations suggest that the socio-ecological characteristics of the wild goats is fundamentally the same as that of the feral goats on Chichijima.

II. The Comparison between the Natural Herd of the Wild and Feral Goats and the Pastoral Herd of the Domestic Goats

Comparing the socio-ecological characteristics of the domestic goat of Samburu with that of the wild and feral goats, we notice in the first place that the pastoral herd is a stable group with constant membership, while the natural herd is only an unstable group without constant membership.

Imanishi (1948) stated as follows:

Among animals living in aggregations, there are various social structures from stable aggregations to fluctuating ones. For example, from my observation, the aggregation of the common *howan-yan* of Mongolia [Mongolian gazelle, *Procapra gutturosa*] is not stable; the membership of an aggregation fluctuates continuously.... Thus I would like to assume that the animals in the forest or on the steppe form stable aggregations continuously, which *howan-yan* does not form.... I assume that the aggregation of wild horses or wild sheep on the steppe, like that of monkeys living in the treetops of a tropical forest (the author's note: howler monkey), was an ideal one; the aggregation was maintained as a kin-related social unit with its definite nomadic range, and this nomadic range which supported the aggregation itself was kept without disturbing others unnecessarily.

Umesao (1976) stated as follows:

As well as in the wild situation before domestication, the pastoral domestic animals lived in aggregations. They had a tendency to form aggregations. Just like the aggregation of monkeys, there was a systematic social organization in aggregation of such animals. The aggregation is not a mere mixture of individuals, but a kind of controlled organization. There was some kind of leader, each member recognizes each other, and it was maintained by the connection between members each of which had a character.

Both Imanishi and Umesao assumed that there was a stable group with unity like the troop of primates in the society of ungulates before domestication, and based on this assumption they constructed their original theories on the origin of pastoralism. In the society of wild and feral goats, however, the stable group like primates' has not yet been observed as mentioned above. In this respect it is the same for the sheep (Schaller, 1977; Kawai, 1989), and probably for the cattle (Kimura & Ihobe, 1985), because there is no stable group in the society of the feral cattle on Kuchinoshima Island. These observations suggest that both Imanishi's and Umesao's assumptions are not valid.

From this conclusion the following problem is posed: If there is no stable group with unity before domestication, what is the pastoral herd of the bovine domestic animals? How was it formed? How is it maintained?

In this section, I discuss, first of all, the cause for the members of the pastoral herd to aggregate, and next, the problem on the unity of the pastoral herd.

III. On the Cohesiveness of Pastoral Goat Herd

1. The Relationship between Migration and Herd Structure among Ungulates

Among the African ungulates that live in the savanna or in the semi-desert, the

springbok (*Antidorcas marsupialis*) of southern Africa that usually live in a definite area is known to migrate suddenly when the environment becomes worse (Bigalke, 1966). In the east Africa, the wildebeest (*Connochaetes taurinus*) in the Serengeti Plain is known to stay in one area for only a few months and migrate approximately 1,500 km in a year, but the wildebeest in the Ngorongoro Crater stays in the same area for a long time (Talbot & Talbot, 1963).

Regarding the African ungulates, Leuthold (1977) points out an interesting relationship between their group formation and their land using system. The wildebeest in Serengeti tends to form large aggregations, i.e. superherds, numbering tens and occasionally hundreds of thousands and containing animals of both sexes. Territoriality is largely confined to the relatively short rutting season. However, a substantial proportion of the Ngorongoro wildebeest is sedentary. Males maintain a network of mating territories throughout the year, and females and their young form fairly coherent groups numbering about ten animals each, which sometimes coalesce into larger aggregations (Estes, 1966, 1969). Similar, but considerably less pronounced differences are evident between Ngorongoro and Serengeti populations of Grant's and Thomson's gazelles (Walther, 1972). Jarman (1974) dealt with the formation of superherds and related propensity for migration as a characteristics of only his class D species such as the wildebeest and the hartebeest. However, Leuthold (1977) also stated as follows: "These traits are neither characteristic nor peculiar to the Alcelaphines, and under environmental conditions Thomson's gazelles, springbok, white-eared kob, and possibly other species form large aggregations and undertake considerable migrations."

Aggregation to form a large group while migrating, and dispersion into small groups while settling in the definite range are rephrased as the migratory phase for aggregation and the sedentary phase for dispersion.

Is the same socio-ecological pattern also applied to the case of the wild and feral goats? The results from the research on the feral goats of Chichijima show that the goat also disperse into small groups while settling (Shikano, 1982). The problem is whether the goat gathers and forms the large group while migrating.

The wild goat (*Capra aegagrus aegagrus*), which is assumed to be the major ancestral species of the domestic stock (Zeuner, 1963), naturally lives in the arid environment such as semi-desert of Pakistan and Afghanistan (Schaller, 1977). Some species of wild sheep such as urial (*Ovis orientalis*), although mainly a woodland animal, also lives in the desert (Schaller, 1977). Such environment as savanna or semi-desert is not only arid but also very unpredictable. The growth of plants, the food for goats and sheep, is much influenced by the precipitation, which, in such an arid land, greatly varies from year to year, and also in the same year varies from one place to another. Thus they live in the area where there is abundant food supply in one year, while there might be none in the next year.

Through the process of evolution in such unpredictable environment, the land using system of these ungulates became flexible as to cope with the various degrees of environmental changes. In the stable environmental condition they use a definite home range, and against the seasonal or small scale change they only move between

several home ranges. On the other hand, against the drastic and large scale change they migrate beyond their usual home range.

I observed only once in Chichijima that almost all members of one female group A moved out to the range of the neighboring female group B. At that time, the members of A gathered tightly to form one group, moved approximately 1 km, and went back to their range again. Some members of the female group B, though being near, were not observed to join this procession. This observation is a case of small migration; going out from one home range, and returning back there. The goats remarkably gathered outside of their home range.

No other such cases were reported in the wild and feral goats until now. However, considering the above sole observation as the representative, I hypothesize that the migration is connected to the gathering of individuals in the socio-ecological system of the wild and feral goats.

2. Home Range and the Effect of Nomadism on Cohesiveness of the Pastoral Goat Herd

I observed on Chichijima that one female feral goat, with her first offspring, was using the same range as her mother's (Shikano, 1982). From this observation I concluded that the home range for a female is established in her infant period, under six months old while moving together with her mother.

Among the domestic goats in Samburu, the kids are separated from the adult herd except for the milking time, and they move around the settlement without watch of any definite herder. Applying the conclusion gained from Chichijima, the kids in Samburu recognize the area around the settlement as their home range.

After weaning, kids are herded together with the adult herd. The adult goat herd of Samburu uses the range within the radius of approximately 5 km of the settlement. I call this range as "day-trip herding range." While using the same day-trip herding range for a long time, goats become accustomed to the area outside of their home range, the settlement and its periphery, and this accustomed area becomes a part of their home range. In other words, there is a tendency for the home range of goats to expand slowly.

However, the area which the herd actually uses within the day-trip herding range varies day by day, and there is observed much diversification only in a short period. The actually used areas change seasonally, too, since the food species for goats change from season to season. Thus there is no regular day-trip herding route in Samburu. It is natural to assume that it takes a longer time for the Samburu goat to become accustomed to a definite area.

Moreover, the day-trip herding range itself changes when the settlement moves to another place or when the herd moves to the stock camp. Asahi (1960) reported that the feral goats of the Tokara Islands attached to a very small range of about 500 m² for a long period after they had been moved and released into a new island named Tomogashima. From this observation it is thought that after being detached from their home range, goats become to recognize the small area around which they are released as their new home range, and that it is difficult for goats to expand the new

home range. Considering from these conclusions, it is suggested that the domestic goats, detached from the day-trip herding range, become to recognize the area around the new settlement or the stock camp as their new home range.

To paraphrase, both in case that there is no regular herding route, and in case that there frequently occurs the movement of the settlement or the stock camp, it is thought that the home range of the domestic goat herd is constantly confined to the small area around the settlement or the stock camp. Considering that I made observations just after the object herds were moved into the new settlement, it is just the same situation that the object herds were put in.

In such a situation, it is logically concluded that the day-trip herding is a kind of small migration for the domestic goat. They depart from their home range, i.e. the area around their settlement, in the morning, move and forage outside of it, and return back there in the evening. This conclusion explains the reason why the domestic goats aggregate to form one stable group, i.e. a pastoral herd; because the day-trip herding is a kind of small migration, the domestic goats show the strong tendency to aggregate with one another in unfamiliar areas.

IV. On the Unity of the Pastoral Goat Herd

The cause that makes the members of a pastoral goat herd aggregate, which I mentioned in the previous section, is a kind of crisis hypothesis: When goats face a crisis, they gather and form an aggregation. This aggregation, however, has a tendency to become bigger and bigger, and finally it might become a superherd. Only by this cause, it is difficult to explain the reason why the pastoral goat herd has its discernible unity. I discuss this unsettled problem on the pastoral herd's unity in this section.

The group of primates, such as the Japanese macaque's, is a stable group with distinct outline like the pastoral goat herd. It is thought that these troops are formed by intimate and everlasting social relationships with each other, and in result the troop has its unity. However, it is hard to consider that the pastoral goat herd is formed just as the primate group is formed. For such intimate and everlasting social relationships are not found in the pastoral goat herd. In other words, the members of a pastoral goat herd are "unlabelled" just as Ohta (1982) stated in his paper on the pastoral goat herd of the Turkana. Although in the society of such ungulates as Japanese deer the intimate and everlasting social relationships between mother and her female offspring, which form the matrilineal deer herd, are recognized obviously (Kawamura, 1957), even such relationships between the mother and offspring are not playing a part in forming the pastoral goat herd. Then how the pastoral goat herd can have its unity?

From the observations of the herd-oriented behavior and of the proximity relationships between the herd members, we can point out the following characteristics on the object to which the herd-oriented behavior is taken. First of all, members of a small party which is left from the main herd take the herd-oriented behavior, and it is evident from this observation that goats recognize the spread of their herd.

Secondly, it is evident, too, that goats in acting the herd-oriented behavior are not intended to recover the proximity with other definite members of the herd, but intend to regain their position within the spread of the herd, for the strong proximity between the definite members other than that between a mother and its infant was not observed in the pastoral goat herd. Finally, goats distinguish the herd of their own from others. Thus it is concluded that goats recognize the herd of their own as a whole, and it is the object of the herd-oriented behavior.

The fact that the herd itself is the object of the herd-oriented behavior suggests that the domestic goat forms the identity of the herd of their own. The frame of a pastoral goat herd is given by man at first, and the herd is separated from others by man after all. However, when living under such environment every day, it occurs that goats themselves get acquainted with and form the identity to these surroundings. As an element of their surroundings goats form the identity of the herd of their own.

In short, the unity of the pastoral goat herd is not made as the sum total of relationships between the members, but is made as the result of the following process. Each member of a herd forms the identity of their herd, which exists a priori for goats as a social environment, and this identity confines the object of the herd-oriented behavior only to the herd of their own, and thus the unity of the pastoral goat herd is maintained.

V. On the Effect of Male Castration

In Samburu I observed the birth of goats in almost all months of the first study period, and the informant stated that it occurs in all seasons. This shows that the rut may occur throughout the year if the environmental condition permits. It is thought that this frequent rut is a major cause for the male to stay in the pastoral goat herd.

In the feral goats of Chichijima, however, the rut may occur throughout the year as in Samburu, and the male feral goat has a tendency to wander in a wider area than females, thus a tendency to wander in several female groups. In Samburu, I observed many times that the adult male in the rut ran to the other pastoral herd passing by. Moreover, when Simion's herd was returning back to the small stock camp in 1986, I observed that the non-castrated adult male sheep went away by himself and was lost at last. These observations show that the male domestic goat retains the same behavioral tendency to wander as the feral goat.

For the pastoral people it is a source of anxiety that the male goes away from the pastoral herd. I would like to hypothesize that castration has such an effect as to suppress male's tendency to wander or as to keep them stay in the pastoral herd. For it is assumed that there is a sexual motivation behind male's wandering, and it is thought that males lose not only such sexual motivation but also the behavioral tendency to wander by being castrated. In other words, they lose the nature of male both physiologically and sociologically. Ohta (1982) reported that the castrated males of Turkana goats forage in larger parties than the non-castrated males do. This

observation, although insufficient, seem to support this hypothesis. The male goat becomes a member of the pastoral herd by being castrated.

CONCLUSIONS

The pastoral goat herd is considered to be formed as a result of integration of the following two causes:

First, the day-trip herding is a kind of migration for domestic goats, and it is thought that this makes goats gather. This mechanism explains the drive of the herd-oriented behavior.

Second, each member of a goat herd has the identity of its own herd which exists *a priori* for goats as a social environment, and this identity of the herd explains the reason why the object of the herd-oriented behavior is confined to the herd of their own.

In short, goats that form the identity of one pastoral herd gather in the process of the day-trip herding, i.e. a kind of migration, and thus a pastoral goat herd becomes a stable aggregation with its distinct unity.

Inferring the origin of the pastoral goat herd on the basis of the above conclusions, it is difficult to assume that man habituated a natural herd of the wild stock. This hypothesis assumes that there is a stable herd with discernible unity in the society of wild ungulates. From my observation on the feral goats of the Ogasawara Archipelago, however, it is made clear that the natural herds of feral goats are not stable ones with no distinct unity. Moreover, it is probable that the stable herd which is the supposed object to be habituated by man does not exist in the wild goats' society.

Instead of such a hypothesis, the origin of the pastoral herd is explained far more easily by assuming the process that man caught infant goats and increased this stock at his basement place. It can be inferred as follows. First, goats form the intimate relationship with man very easily by spending their infancy in the artificial environment (Hale, 1969). Moreover they become to recognize the area around the settlement as their home range in the process of growing there around. Each of these goats form an identity to the aggregation itself. Finally, these goats gather when being taken outside of their home range. It is highly probable that the pastoral goat herd was born in this way.

NOTES

- (1) In these five years people around Mabati have begun to keep chickens and to eat their meat and eggs. However, there are many persons who refuse to eat them until now.
- (2) The time of departure is usually delayed in the morning after rainfall. The Samburu explains that the small stock's feet are easy to get infected if soaked.

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